Ten Years at the Calif. Energy Commission & White Roofs to Cool your Building, your City and (this is new !) Cool the World

ClimateWorks
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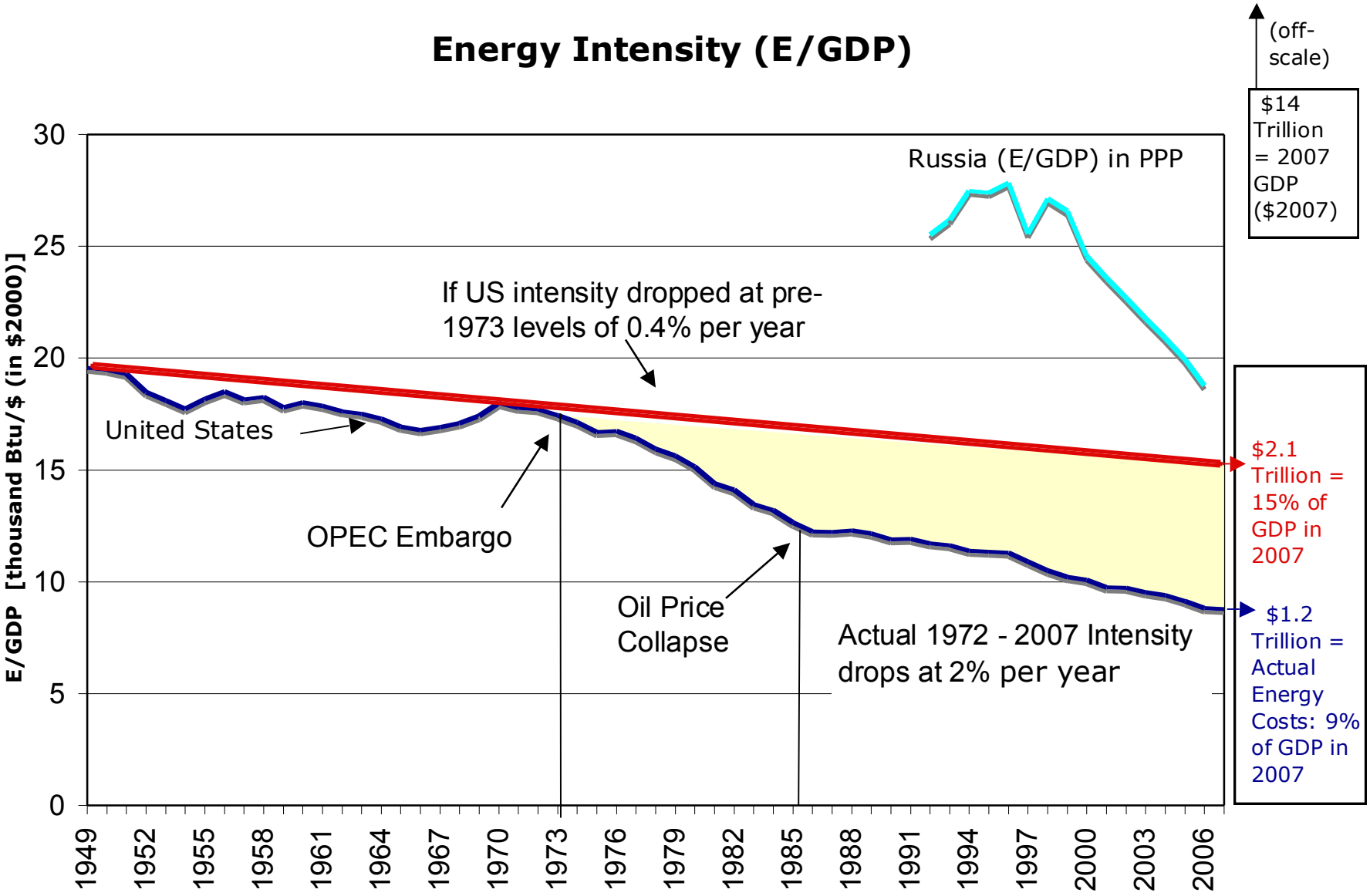
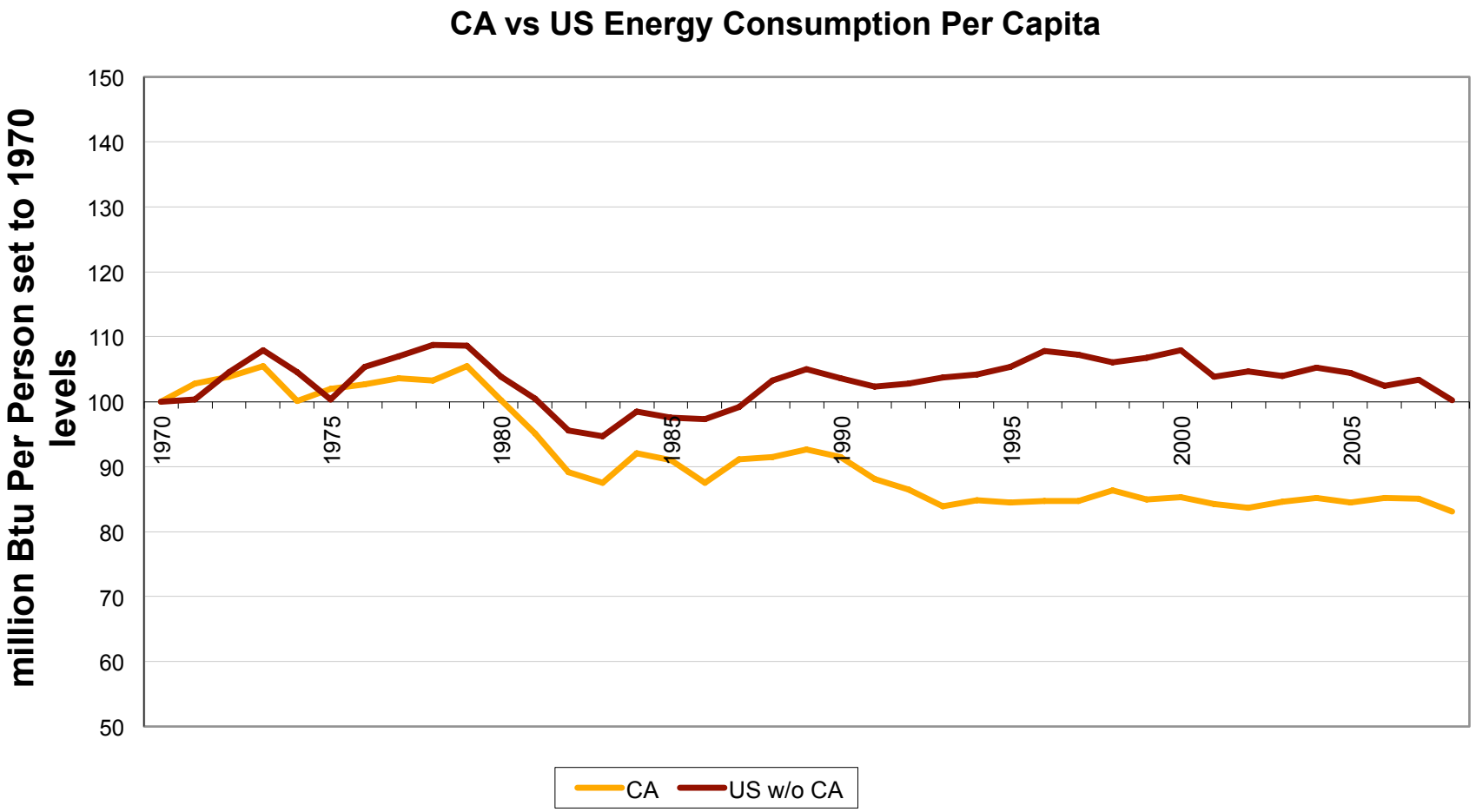
Arthur H. Rosenfeld, Former Commissioner
California Energy Commission.

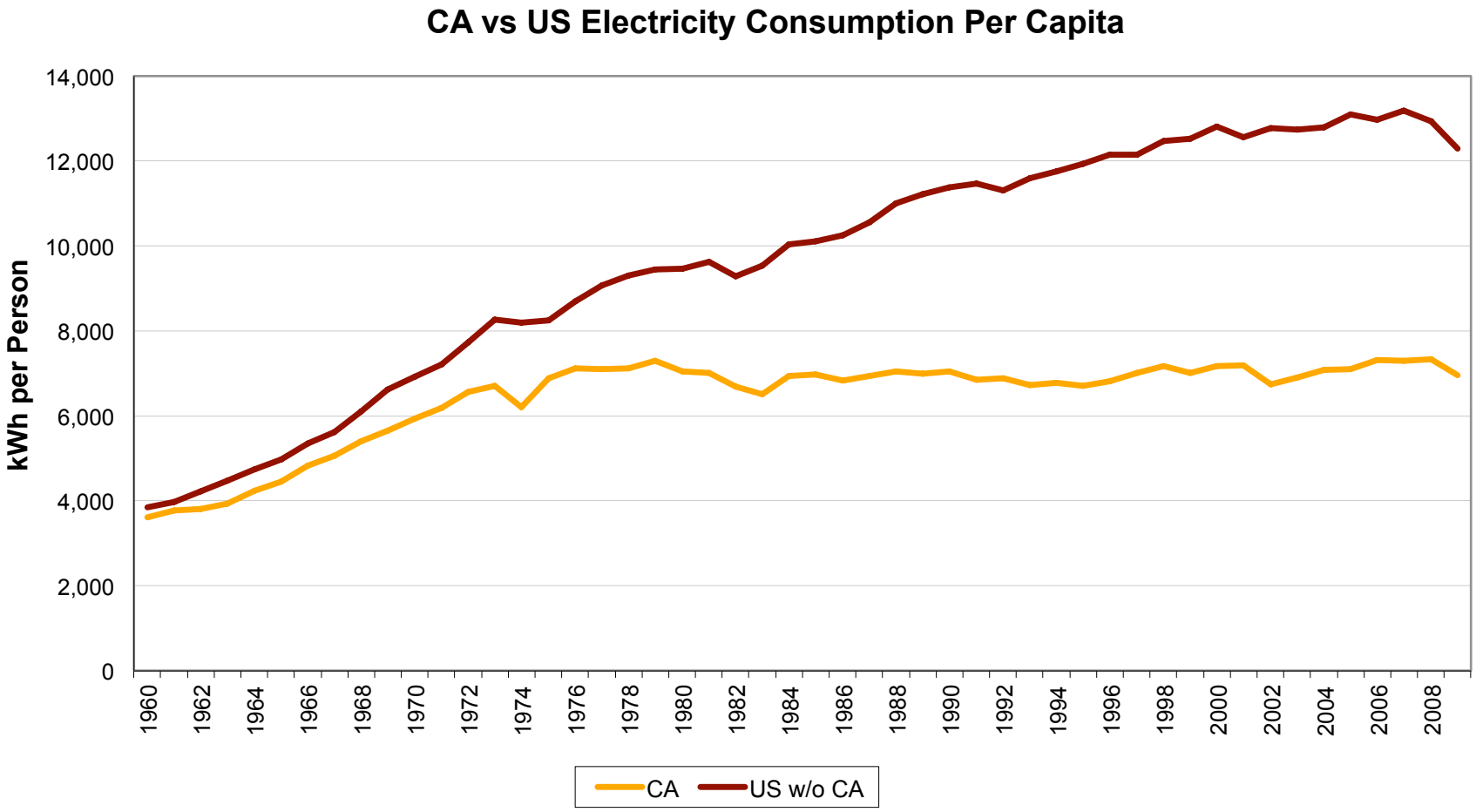
Distinguished Scientist Emeritus
Lawrence Berkeley National Lab.
AHRosenfeld@LBL.gov
510 495-2227

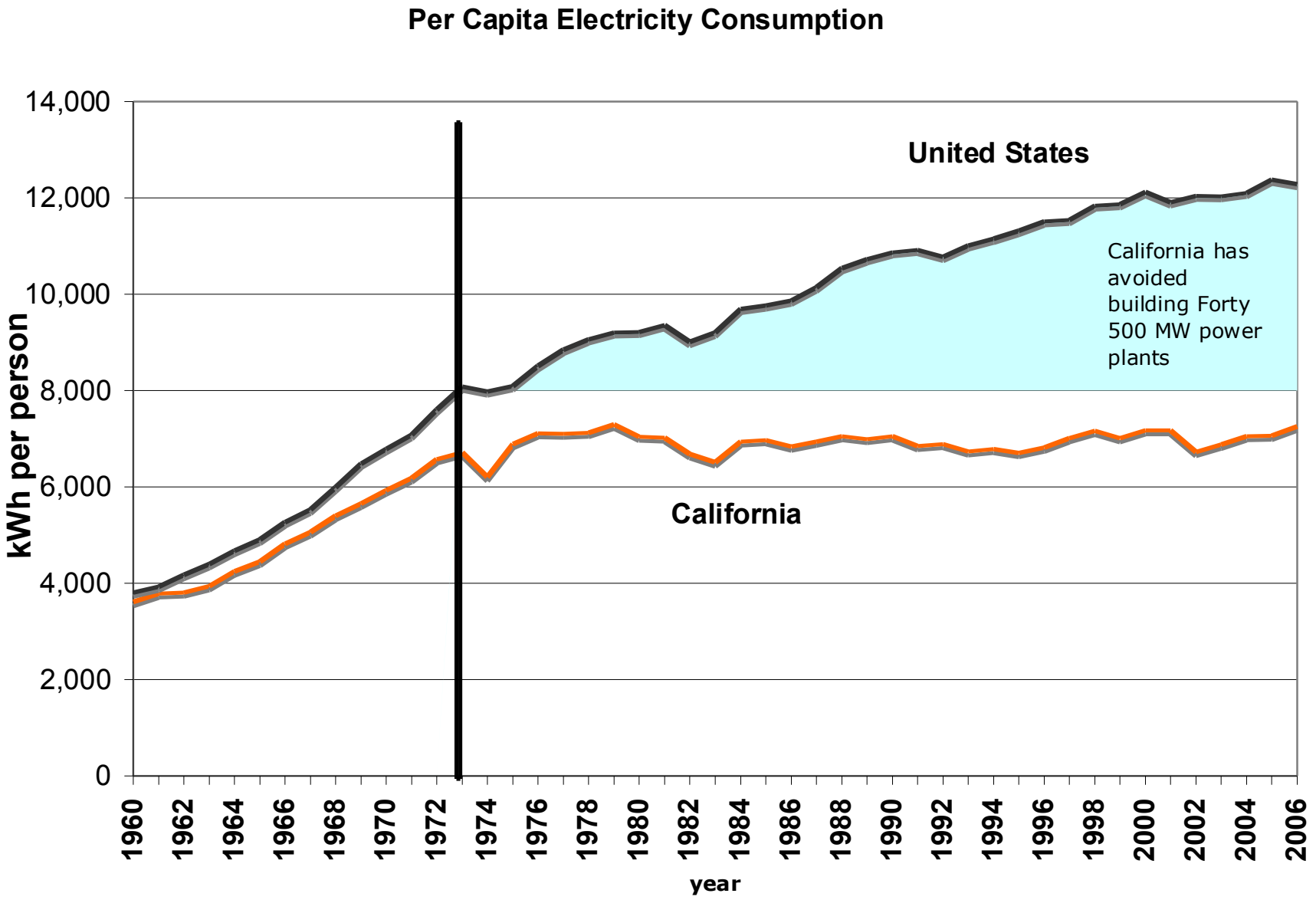
Presentation available at www.ArtRosenfeld.org

File Name ClimateWorksV2 050812

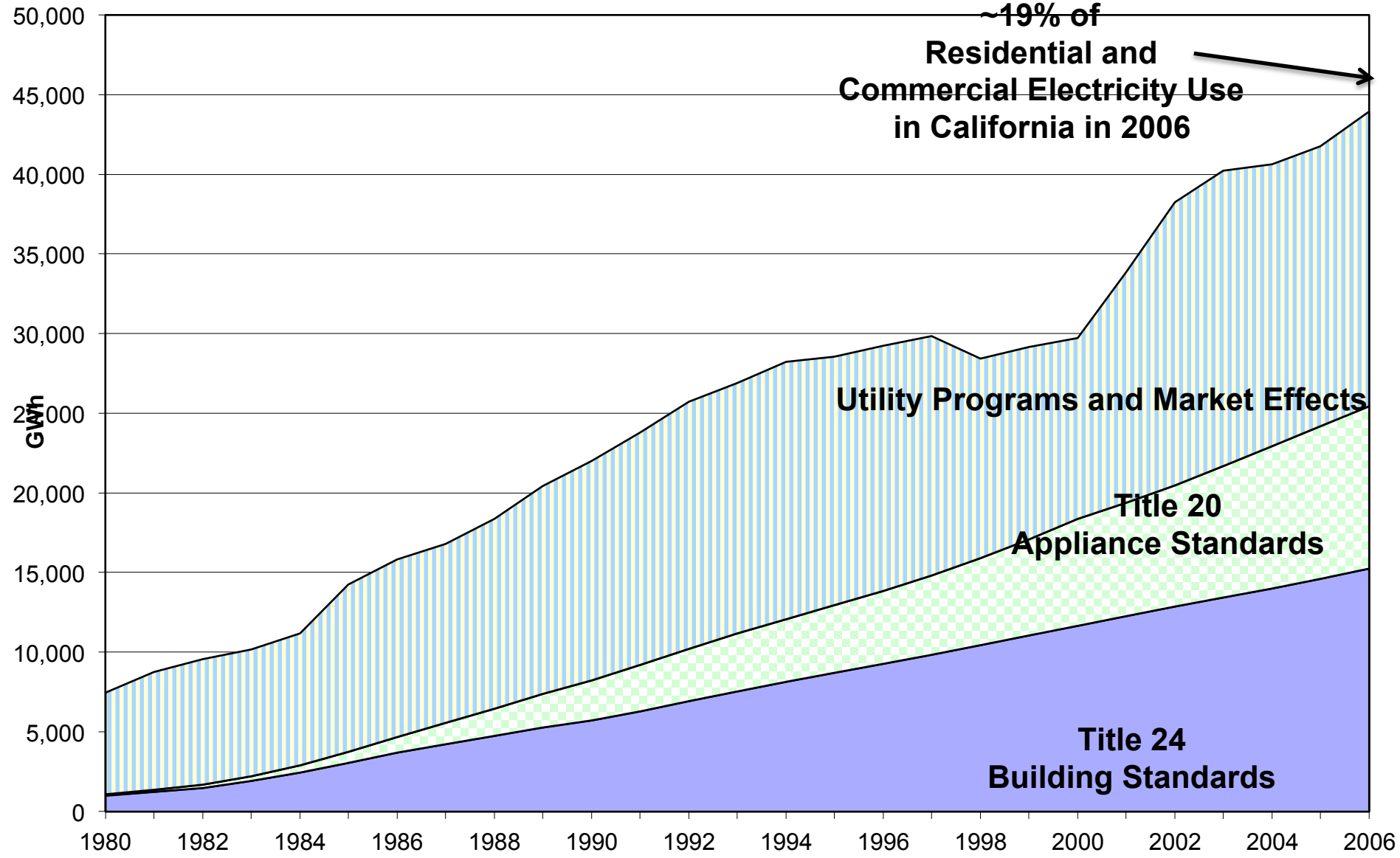

Energy Intensity (E/GDP)
E/GDP [thousand Btu/$ (in $2000)]
30
25
20
15
10
5
0
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
Russia (E/GDP) in PPP
(off-scale)
$14 Trillion = 2007 GDP ($2007)
If US intensity dropped at pre-1973 levels of 0.4% per year
United States
OPEC Embargo
Oil Price Collapse
Actual 1972 - 2007 Intensity drops at 2% per year
$2.1 Trillion = 15% of GDP in 2007
$1.2 Trillion = Actual Energy Costs: 9% of GDP in 2007


CA vs US Energy Consumption Per Capita
million Btu Per Person set to 1970 levels
150
140
130
120
110
100
90
80
70
60
50
1970
1975
1980
1985
1990
1995
2000
2005
CA
US w/o CA


CA vs US Electricity Consumption Per Capita
kWh per Person
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
CA
US w/o CA


Per Capita Electricity Consumption
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
kWh per person
United States
California has avoided building Forty 500 MW power plants
California
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
year

Residential and Commercial Cumulative Conservation Savings 1980 - 2006

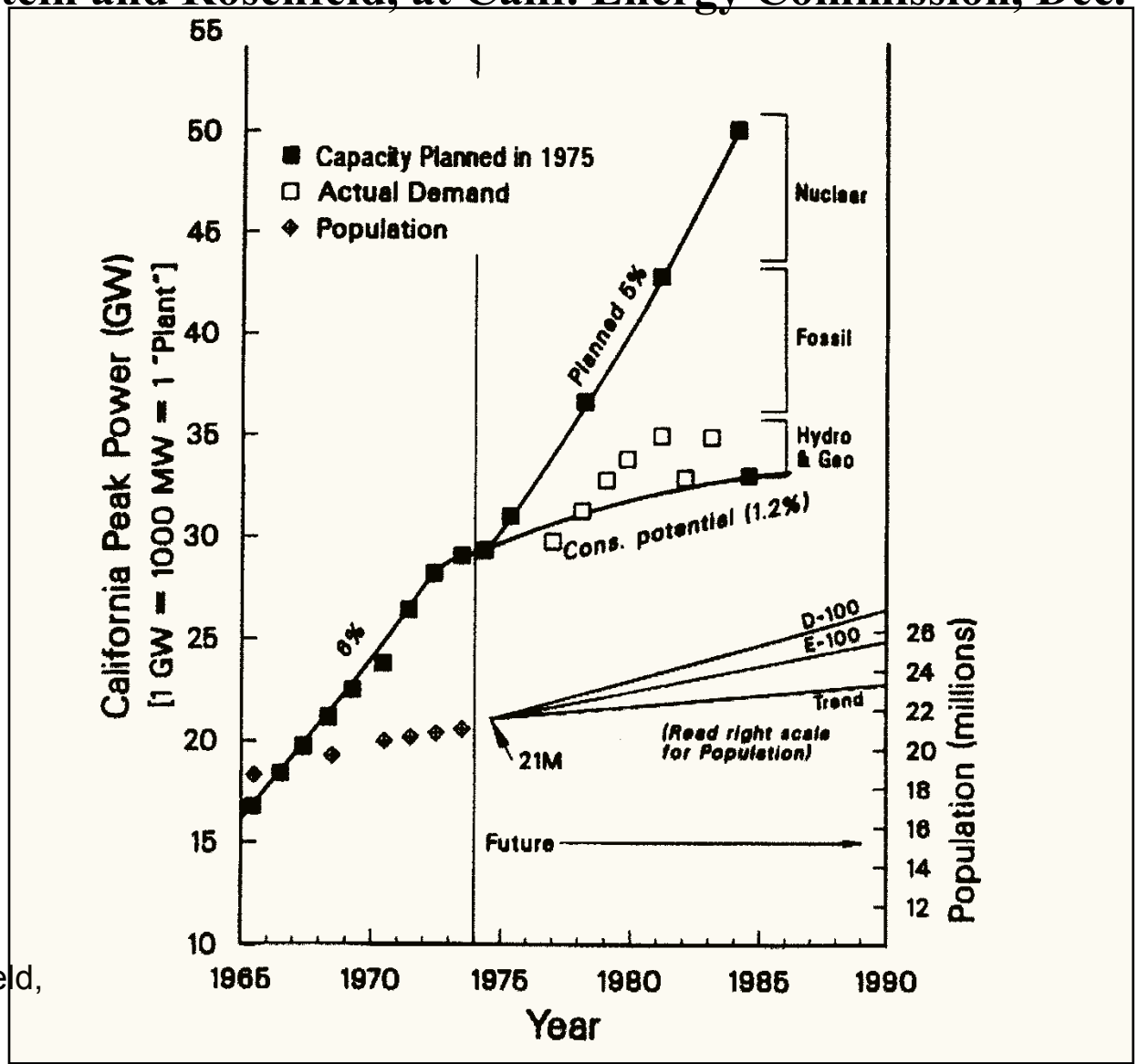


Source: Art Rosenfeld, California Energy Commission

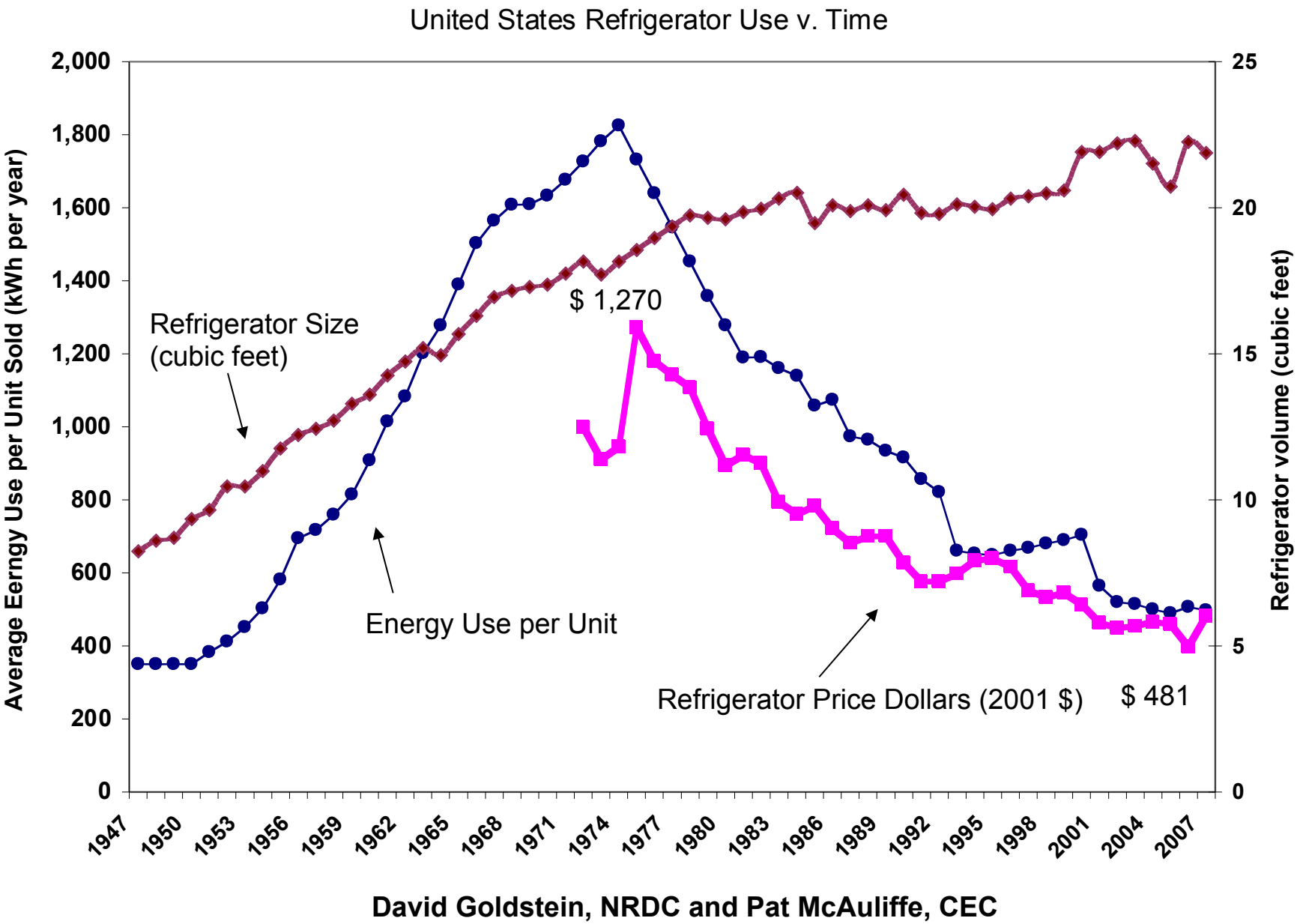
Projections of California Peak Power Demand

Planned in 1974 vs. Actual to 1984

(Goldstein and Rosenfeld, at Calif. Energy Commission, Dec. 1975)

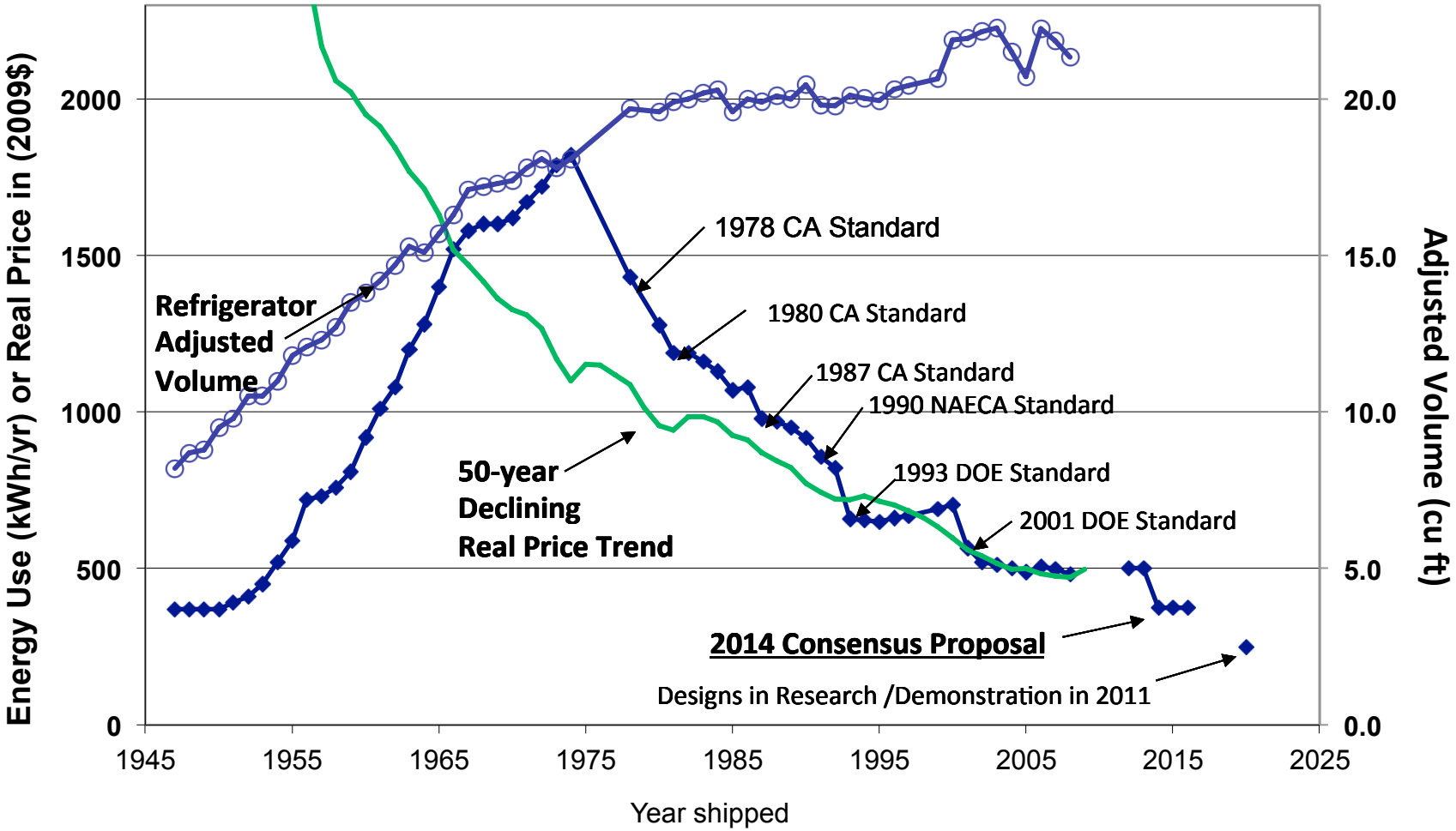


Arthur Rosenfeld,

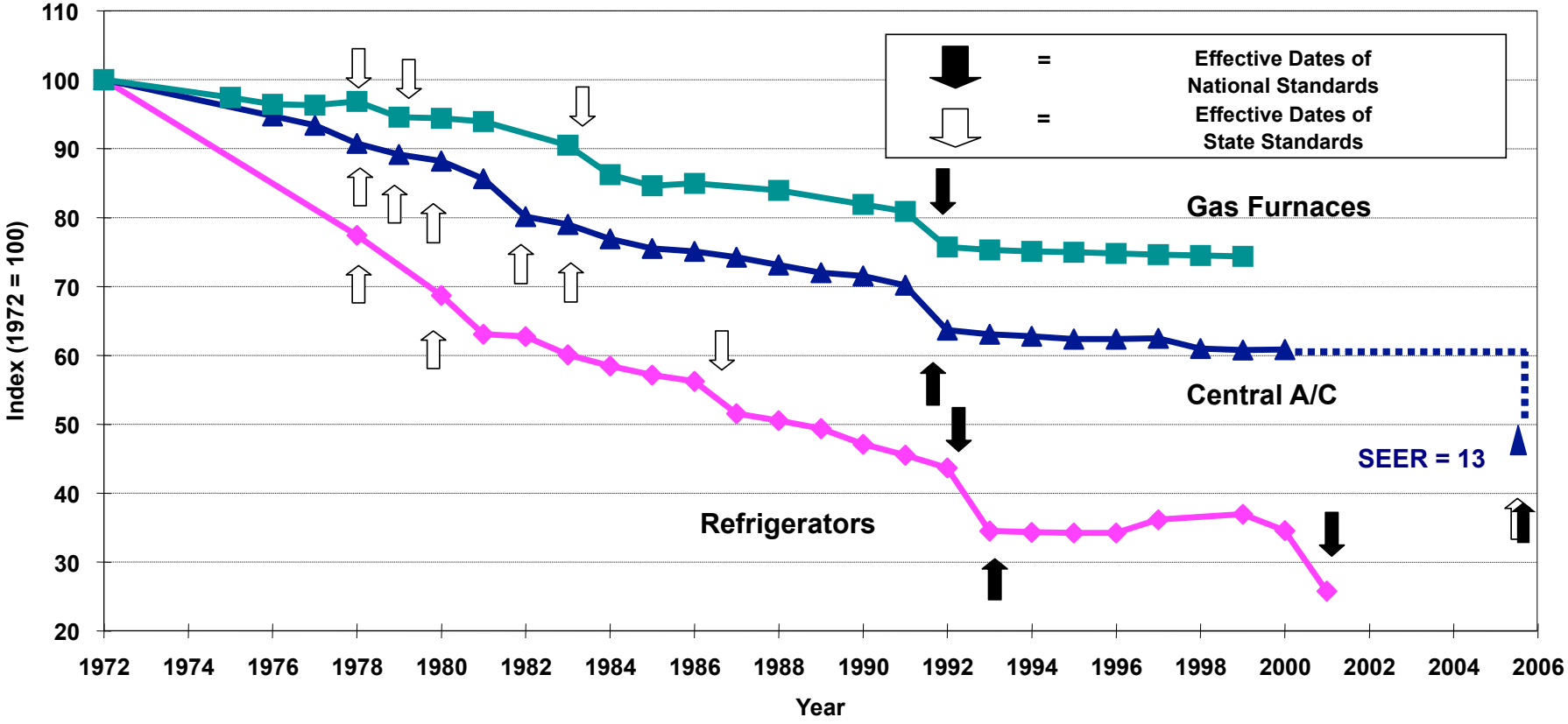

United States Refrigerator Use v. Time
Average Eerngy Use per Unit Sold (kWh per year)
Refrigerator volume (cubic feet)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
25
20
15
10
5
0
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
Refrigerator Size
(cubic feet)
Energy Use per Unit
$ 1,270
Refrigerator Price Dollars (2001 $)
$ 481
David Goldstein, NRDC and Pat McAuliffe, CEC

Annual Energy Use, Volume and Real Price of New Refrigerators

Sources: AHAM Factbooks, Rosenfeld 1999 and Bureau of Labor Statistics



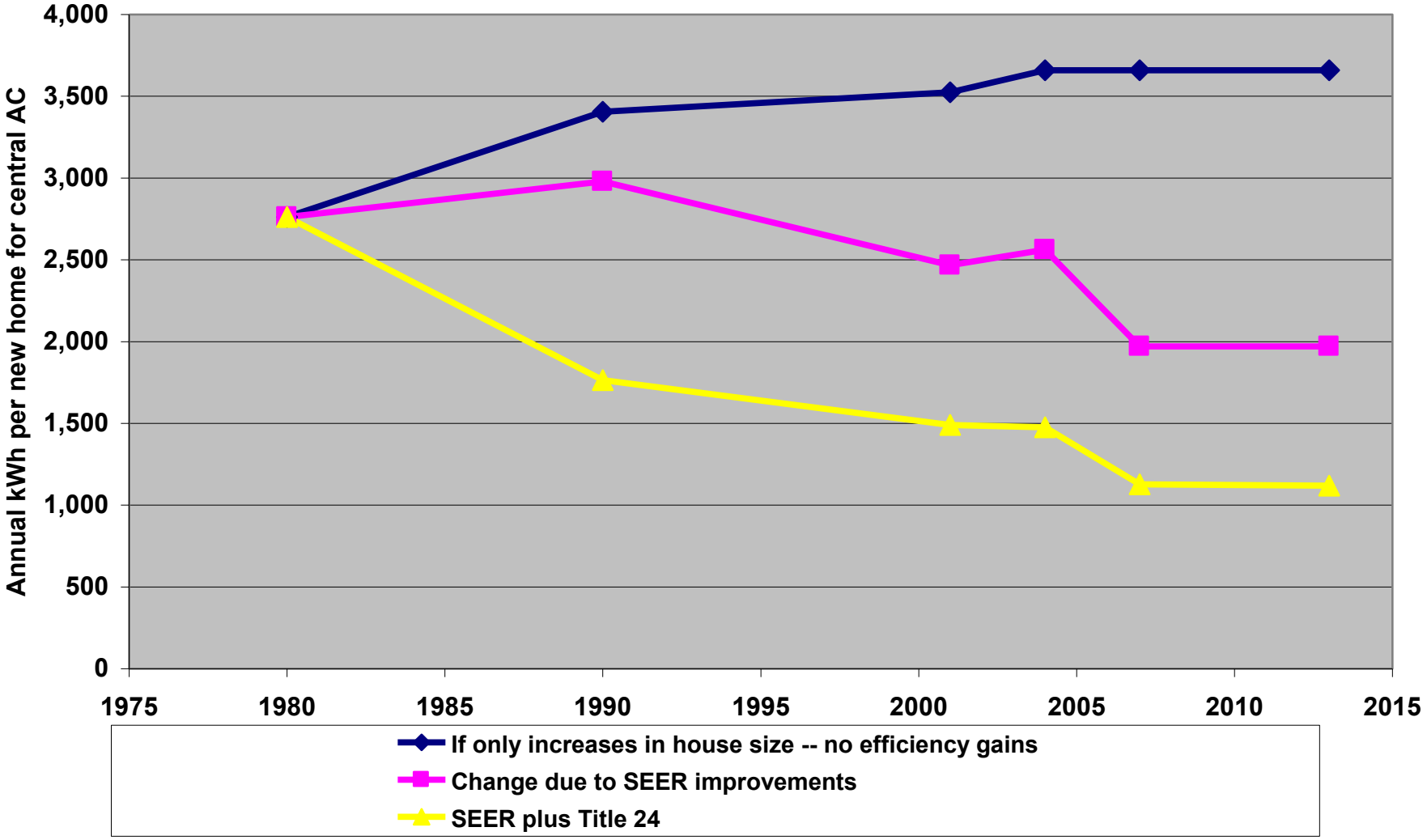
Impact of Standards on Efficiency of 3 Appliances



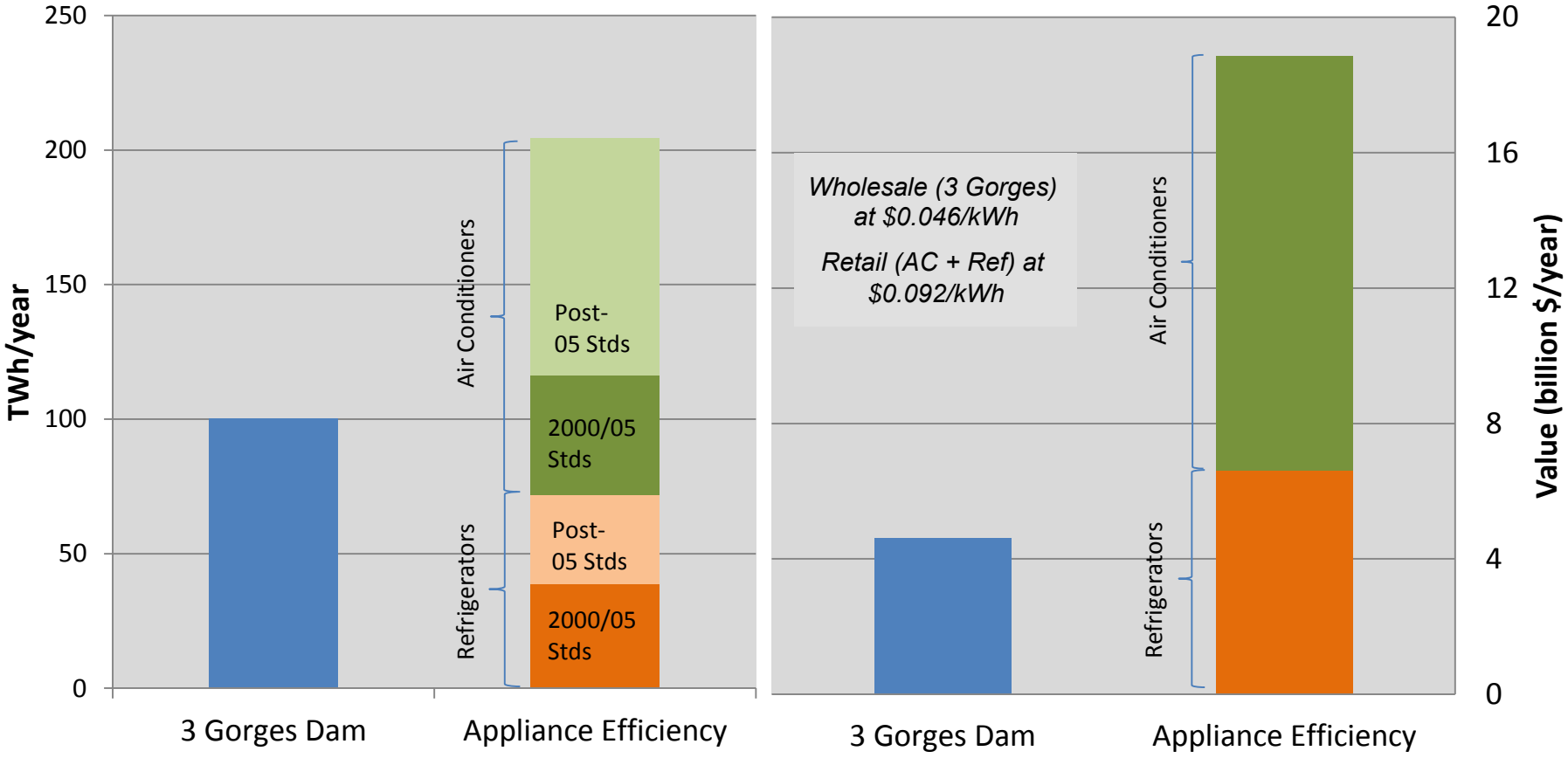
Source: S. Nadel, ACEEE,

in ECEEE 2003 Summer Study, www.eceee.org

Air Conditioning Energy Use in Single Family Homes in PG&E
The effect of AC Standards (SEER) and Title 24 standards



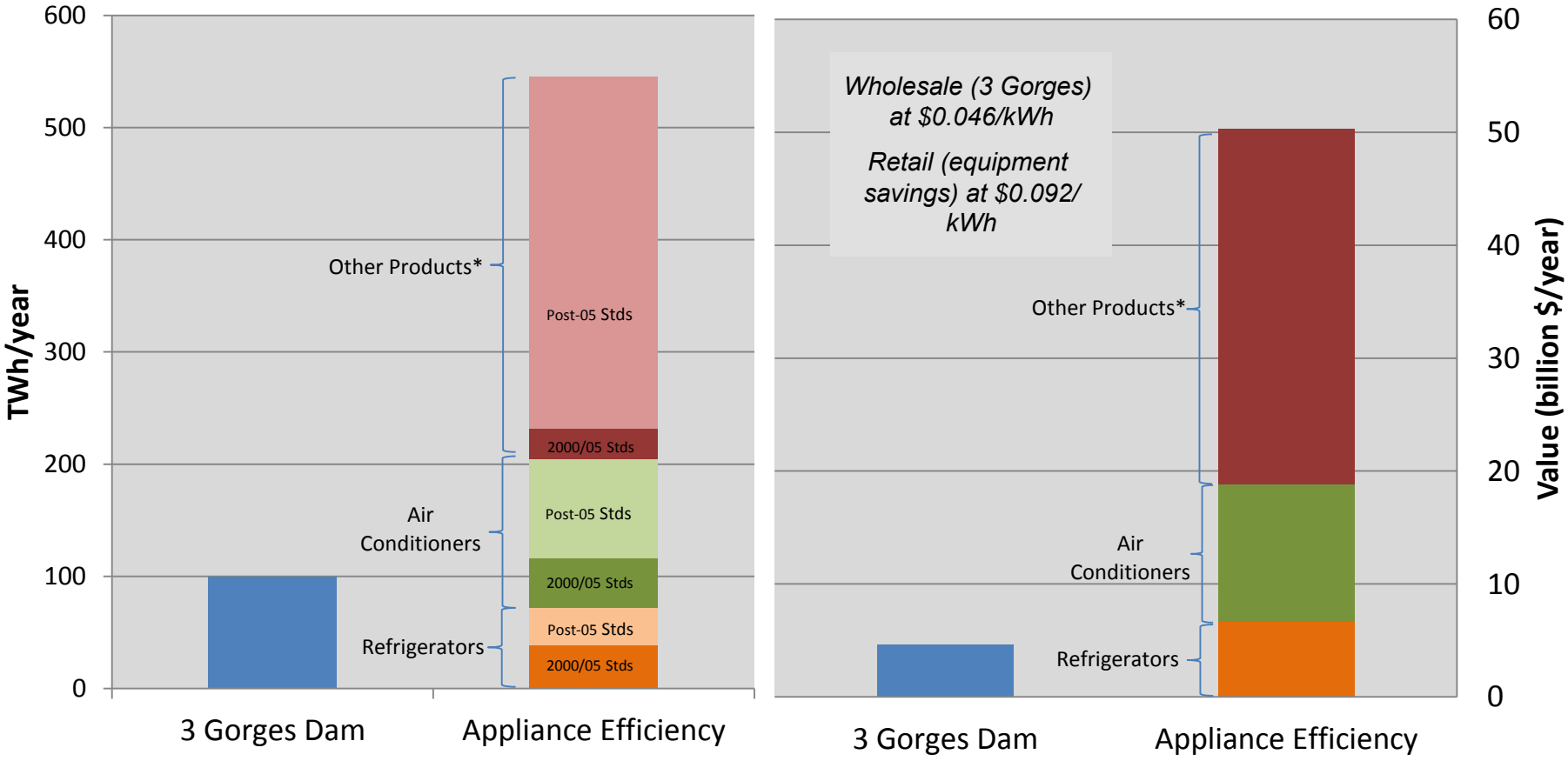
Annual generation from China's Three Gorges Dam compared to annual savings in 2020, from 20 years of sales of refrigerators and ACs with increasing energy efficiency



Appliance efficiency savings are calculated on the basis of annual savings in 2020. "Post-05" standards accounts for China's periodic standards revision schedule of 4 to 5 years.

Source: LBNL China Energy End-Use Model, David Fridley and Nina Zheng, 2010

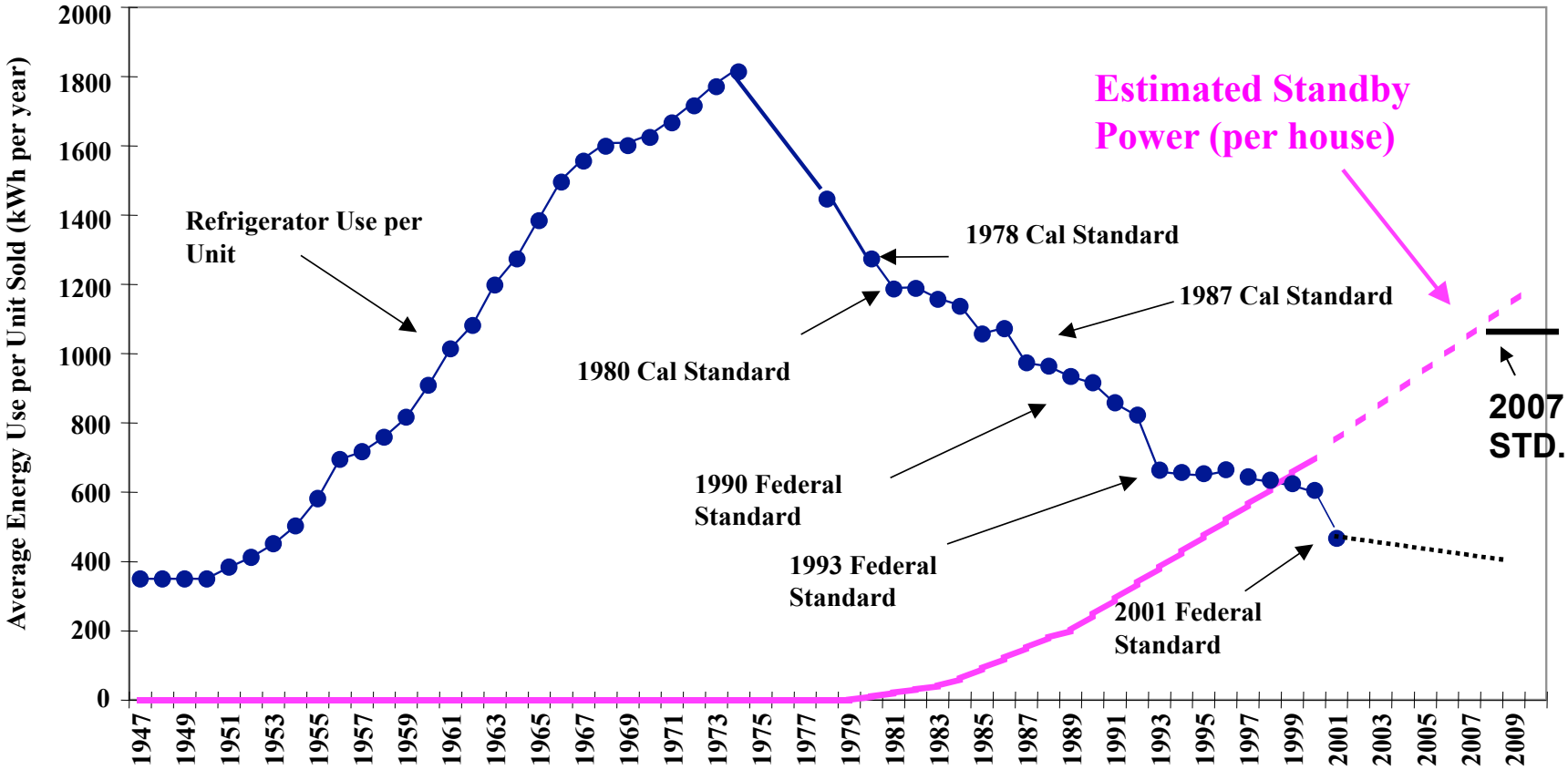
Annual generation from China's Three Gorges Dam compared to annual savings in 2020, from 20 years of sales of equipment subject to China's energy efficiency standards



***Other products include: clothes washer, TV, fans, stand-by power, electric water heater, electric cooktop, fluorescent lamp ballasts, rice cooker, microwave ovens, laser printers, fax, copiers, computer monitors, HID lamps and ballasts, motors, air compressors, transformers, servers, computers, double-capped fluorescents, heat pump water heater, rangehoods, ventilating fans, external power supply, vending machines, LED lamps, grid lighting, commercial AC chillers, water-cooled chillers, unitary AC**

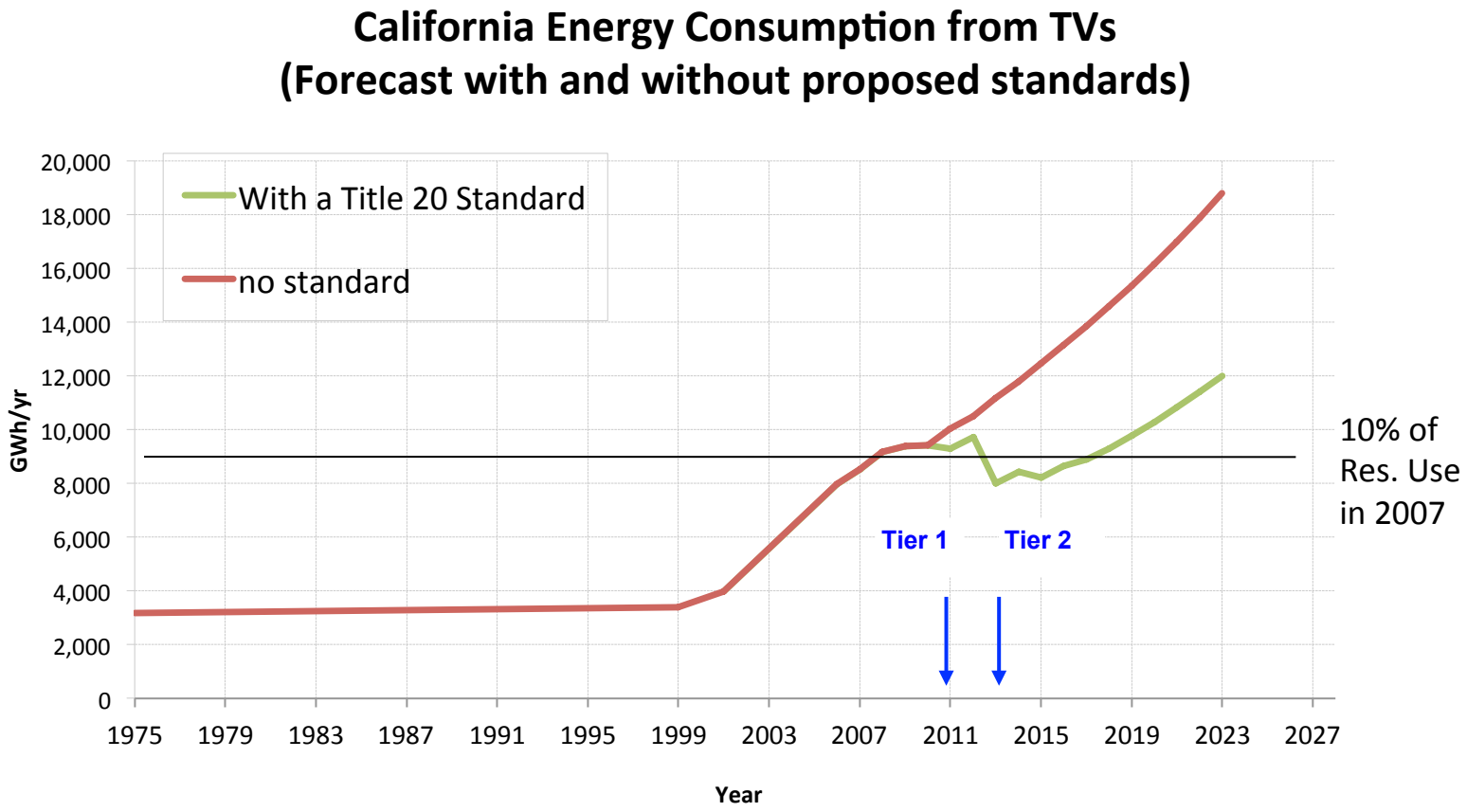
Source: LBNL China Energy End-Use Model, David Fridley and Nina Zheng, 2010

United States Refrigerator Use, repeated, to compare with Estimated Household Standby Use v. Time

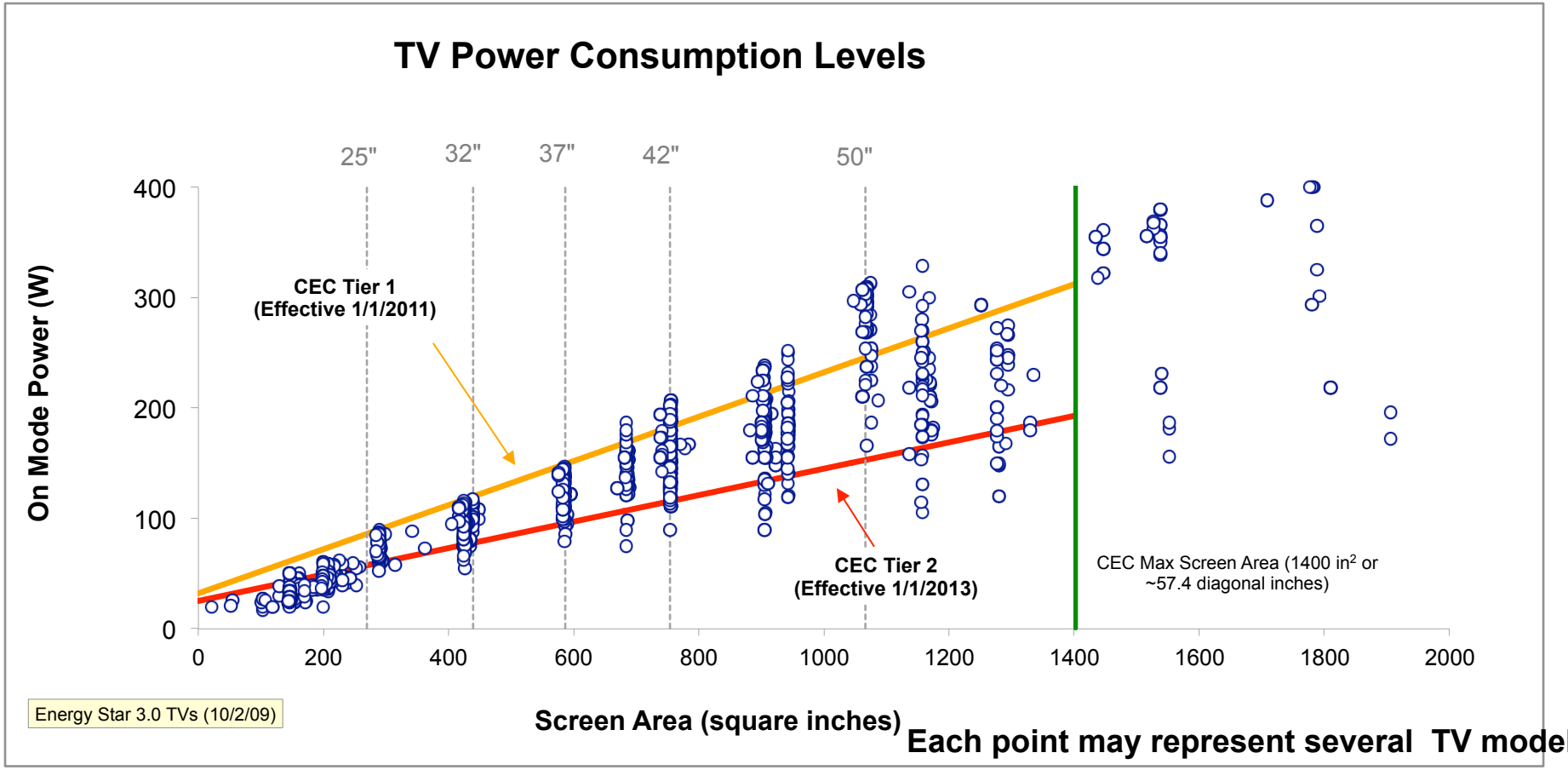


Televisions Represent Significant Energy Use

The residential energy consumption due to televisions rapidly increased from 3-4% in 1990s to 8-10% in 2008. Television energy will grow up to 18% by 2023 without regulations. The projected growth does not include the residential energy use by cable boxes, DVD players, internet boxes, Blue Ray, game consoles etc.



Technically Feasible Standards



***Consumers can expect to save between $ 50 - $ 250 over the life of their TV**

***A 50 inch plasma can consume as little as 307 kWh/yr and as much as 903 kWh/yr**

General Purpose Lighting – Proposed Regulations (cont.)

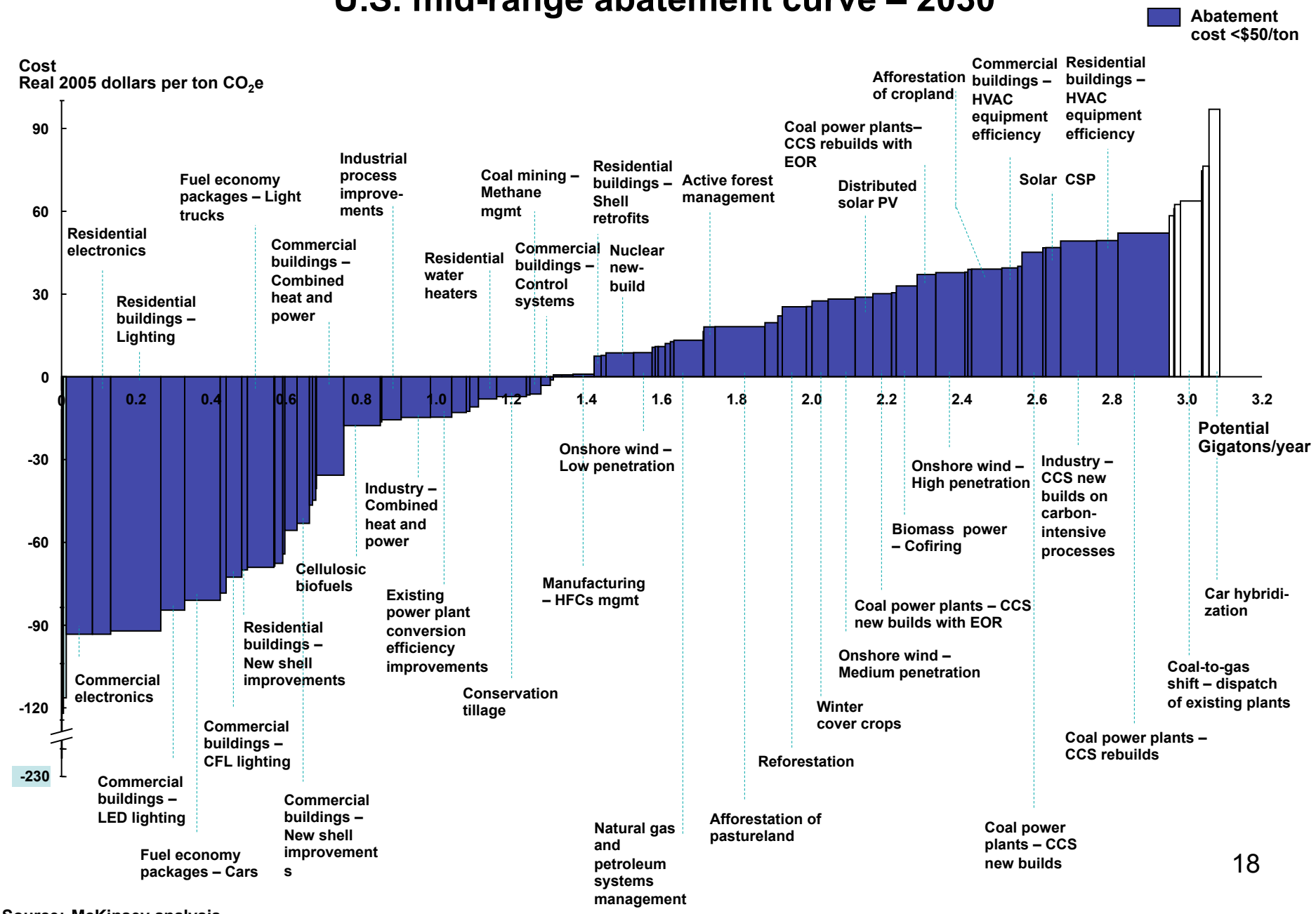
Proposed Table K-8: Standards for State-regulated General Services Incandescent Lamps -Tier I

Rated Lumens Range	Maximum rated Wattage	Minimum Rated Life Time	Proposed California Effective Date
1490-2600 Lumens	100→72 Watts	1,000 hours	Jan, 1, 2011
1050-1489Lumens	75→53 Watts	1,000 hours	Jan 1, 2012
750-1049 Lumens	60→43 Watts	1,000 hours	Jan 1, 2013
310-749 Lumens	40→29 Watts	1,000 hours	Jan 1, 2013

Proposed Table K-9: Standards for State-regulated General Services Lamps -Tier II

Lumens Range	Maximum Lamp Efficacy	Minimum Rated Life Time	Proposed California Effective Date
All	45 lumens per watt	1,000 hours	Jan, 1, 2018

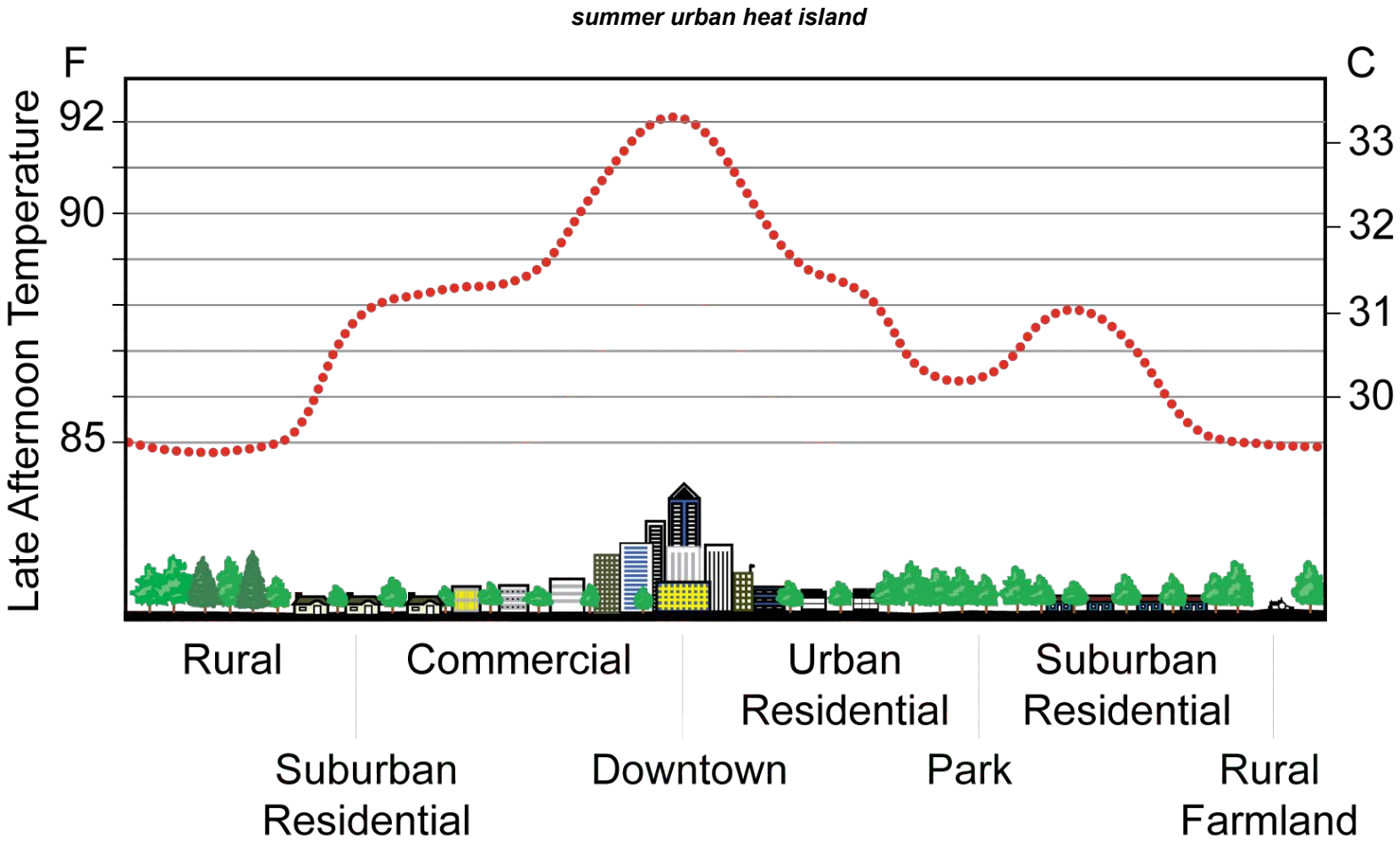
U.S. mid-range abatement curve – 2030



Source: McKinsey analysis

White roofs to cool your buildings, your cities, and (this is new) to cool the earth.

Summer in the city



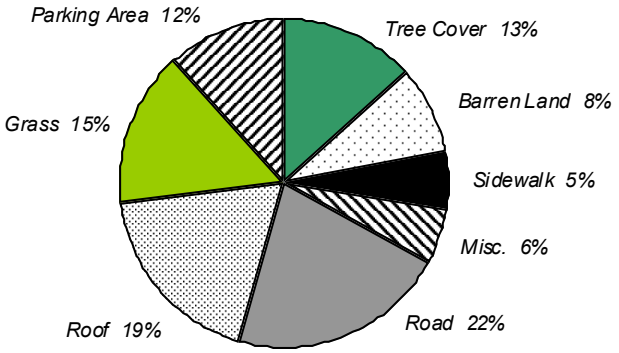
Bird's eye view of urban land use

21

~ 1 km^2

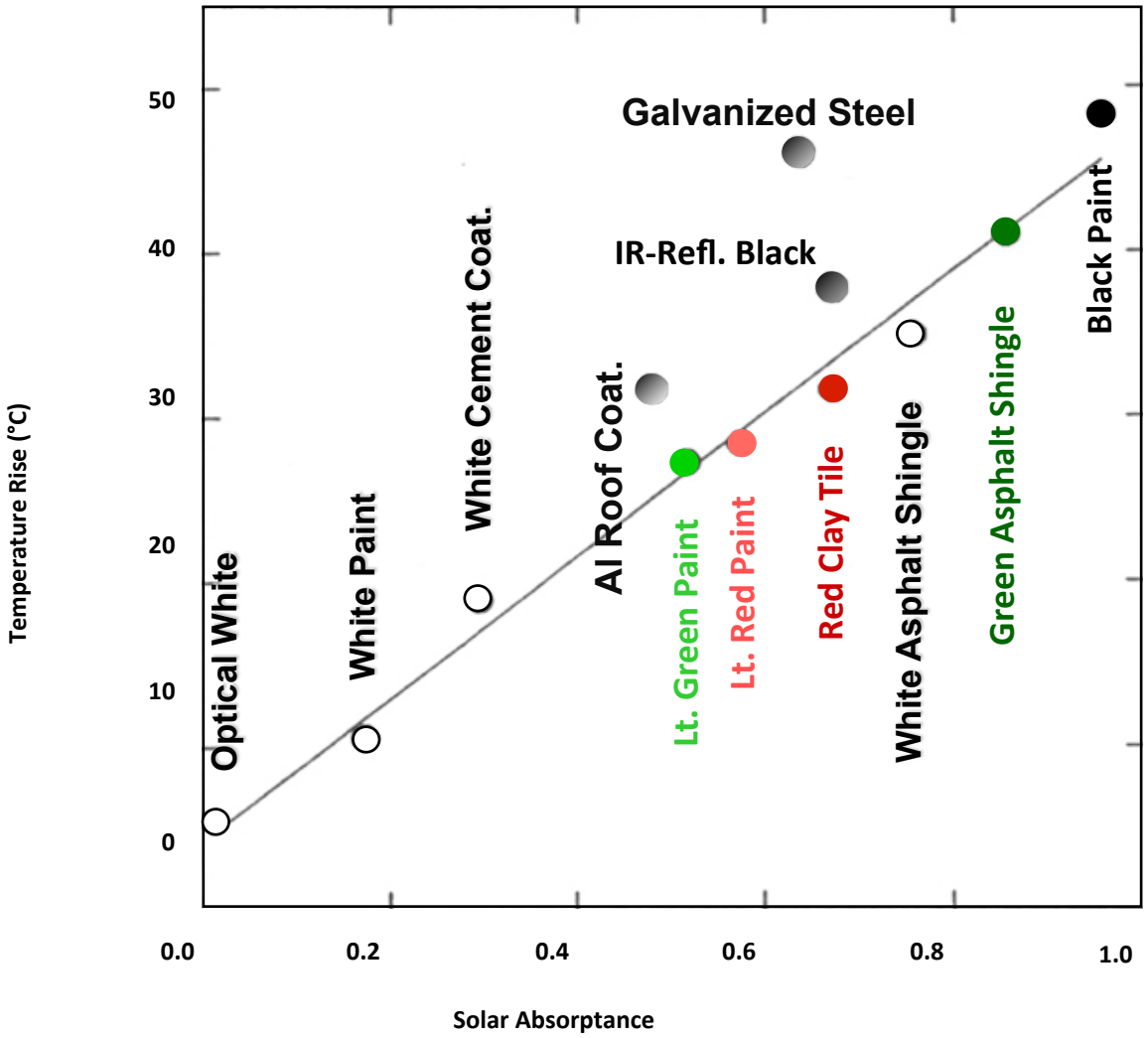
The surface of Sacramento, CA is about

- **20% roofs**
- **30% vegetation**
- **40% pavement**



Area by Land-Cover Category Above the Canopy

Reflective roofs stay cooler in the sun



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White roofs, cool-colored roofs save money

OLD

flat, white

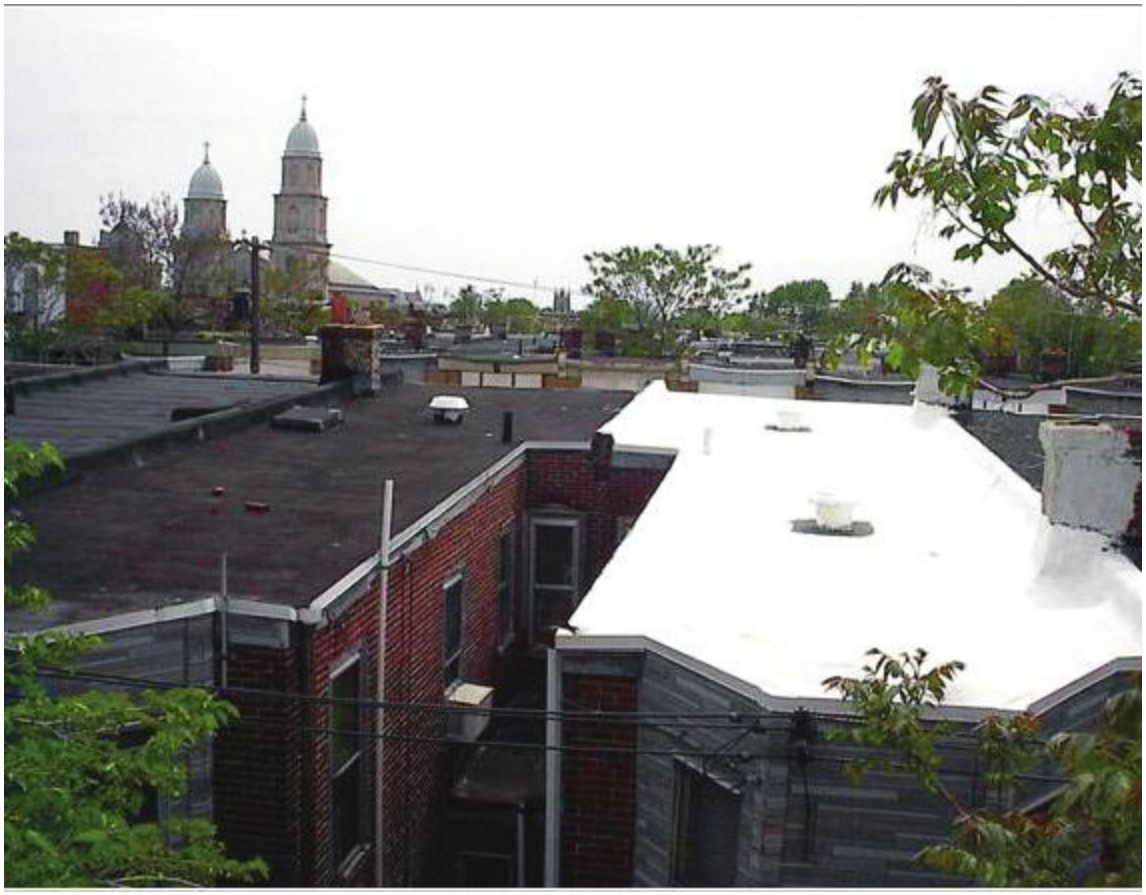
pitched, white

NEW

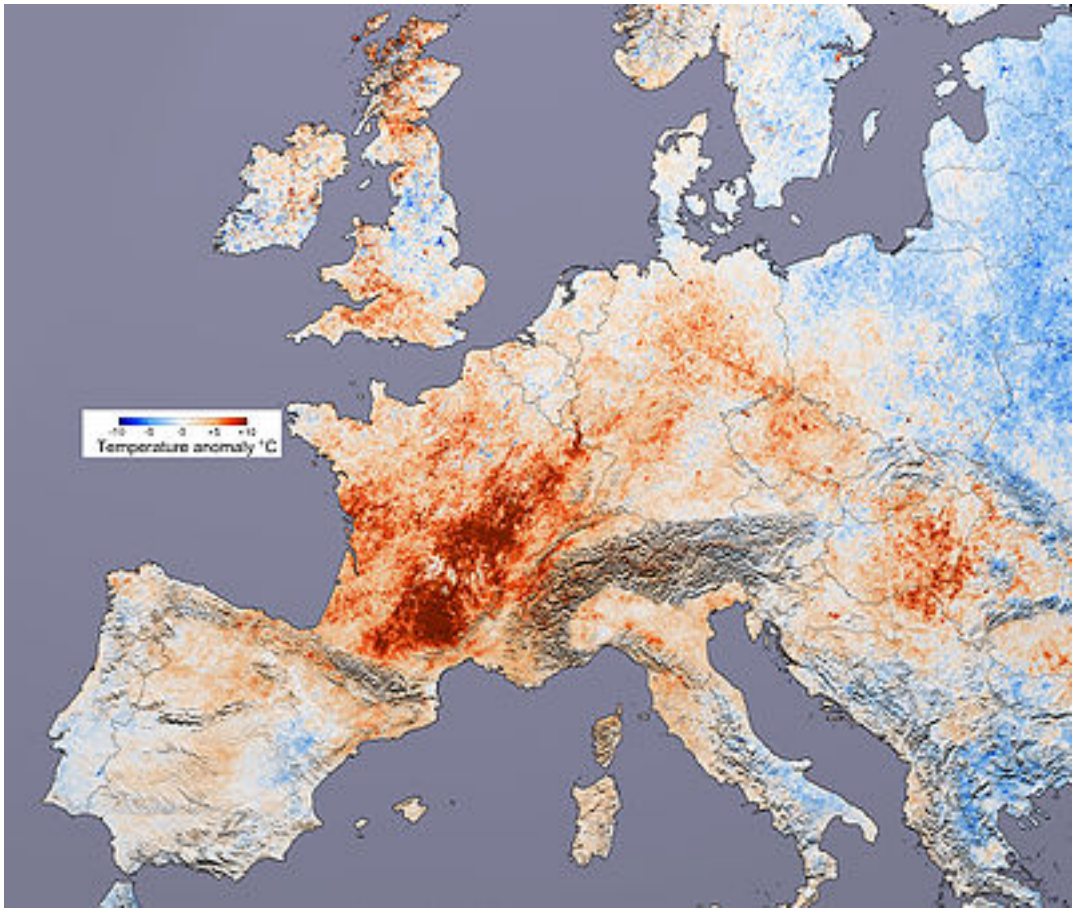
pitched, cool & colored

Chicago Heat Wave 1995, 739 Deaths

Virtually all of the deaths occurred on the top floors of buildings with black roofs



European Heat Wave 2003, 30,000 Deaths
Moscow-Centered Heat Wave 2010,15,000 Deaths

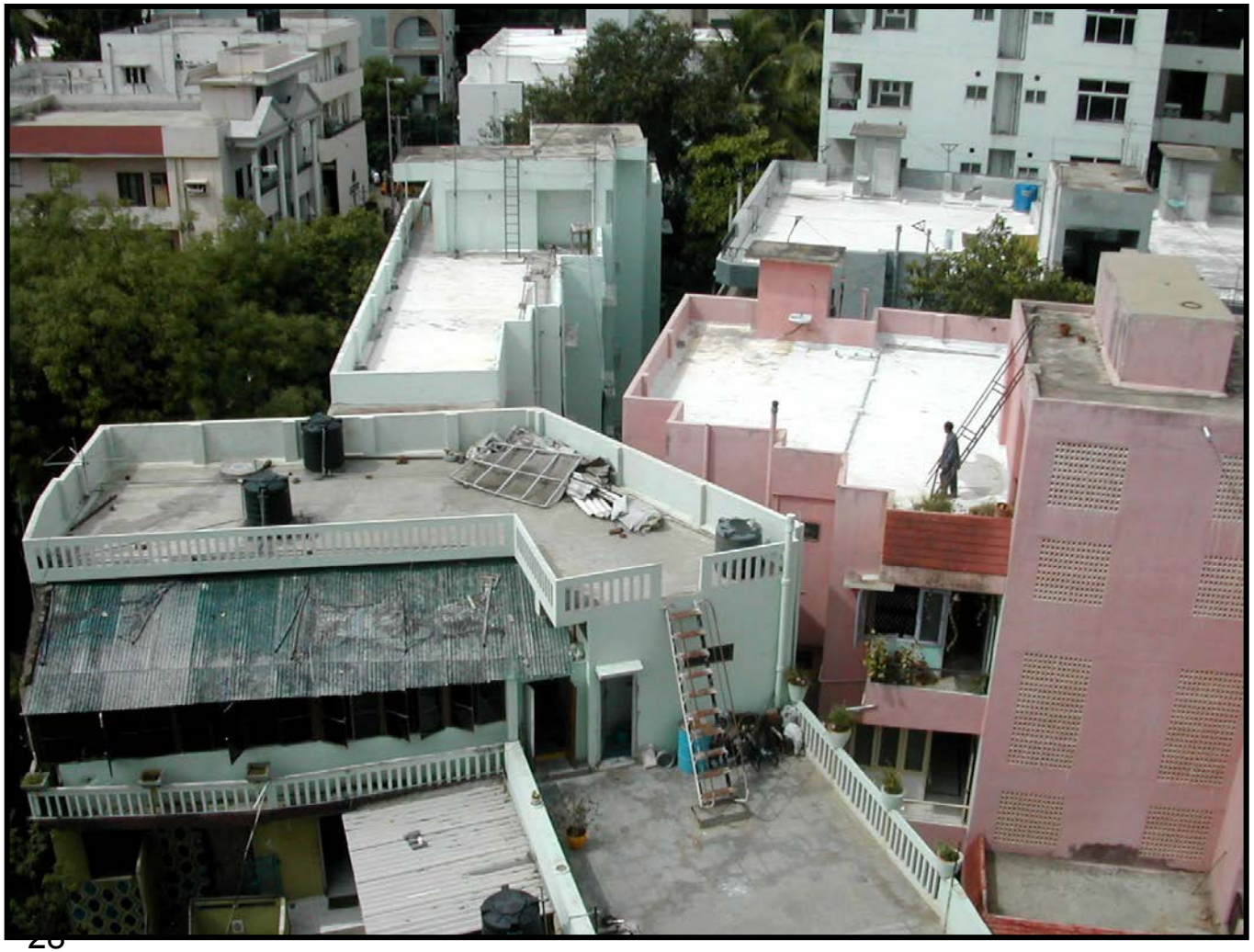


White roofs around the world

…in Santorini, Greece

27

…in Hyderabad, India



…and widely in the state of Gujarat, India.

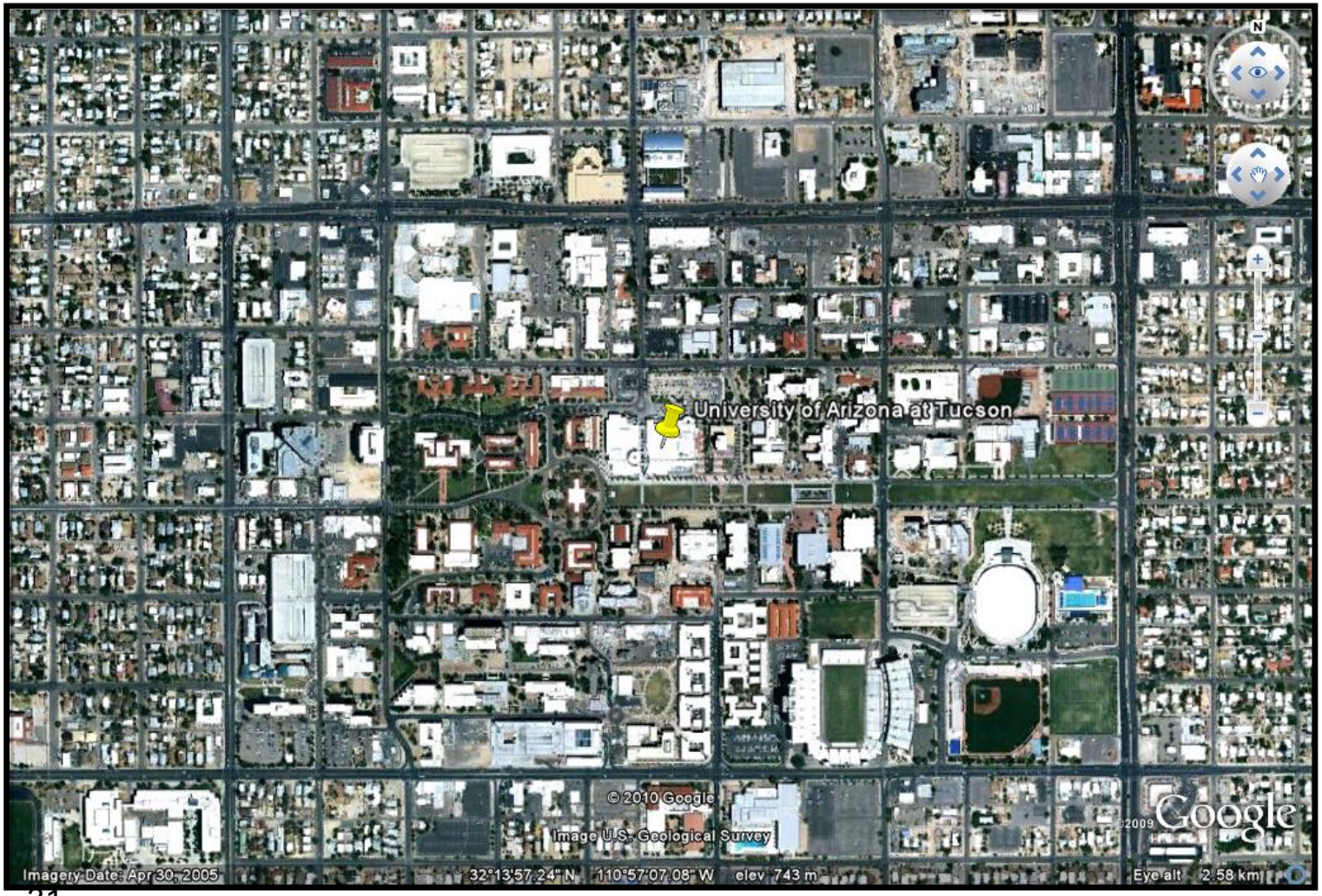
Walmart store in northern California

29

Congratulations to UC Davis

30

White roofs are popular in Tucson, AZ



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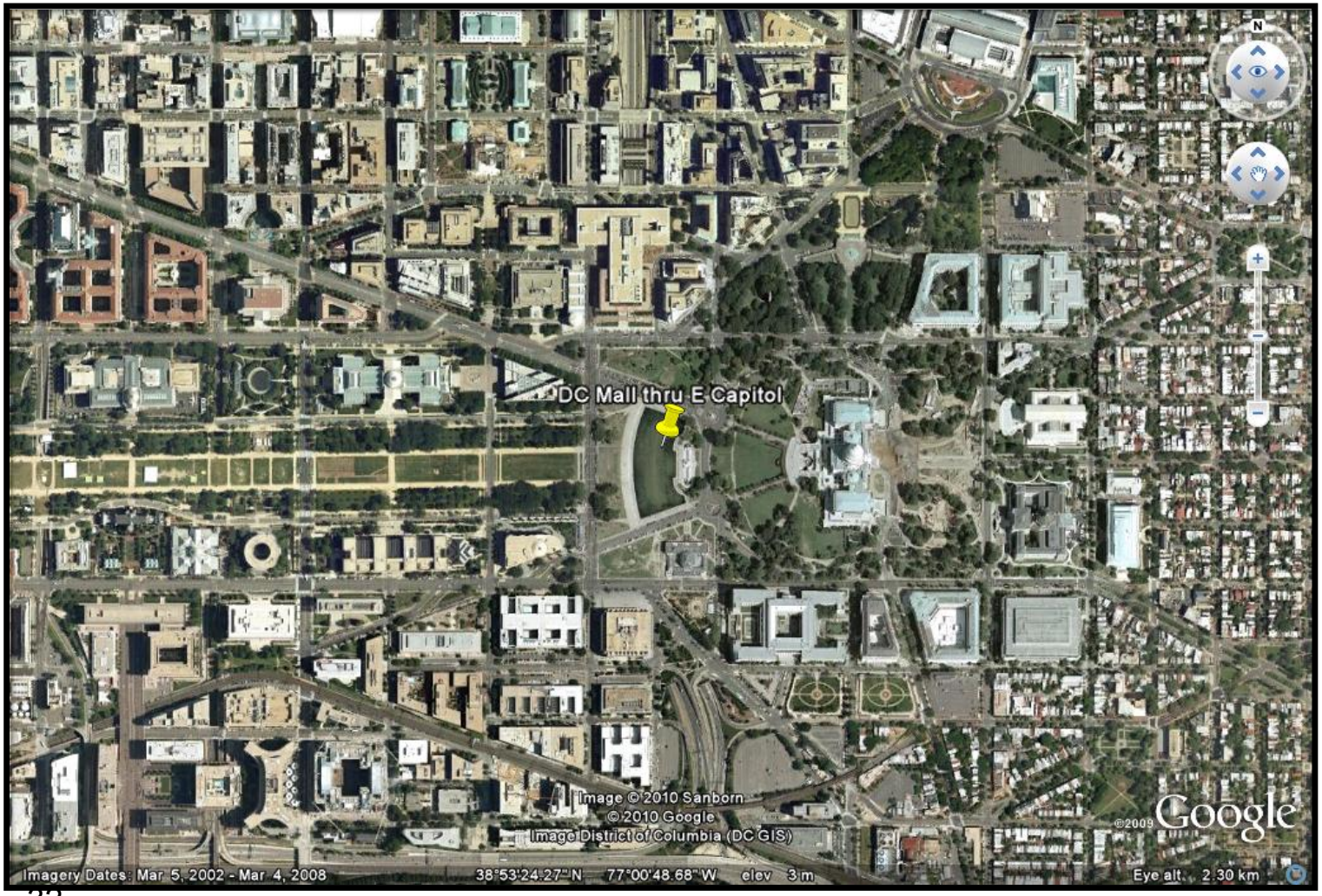
Washington, DC (Federal) has problems with historical buildings



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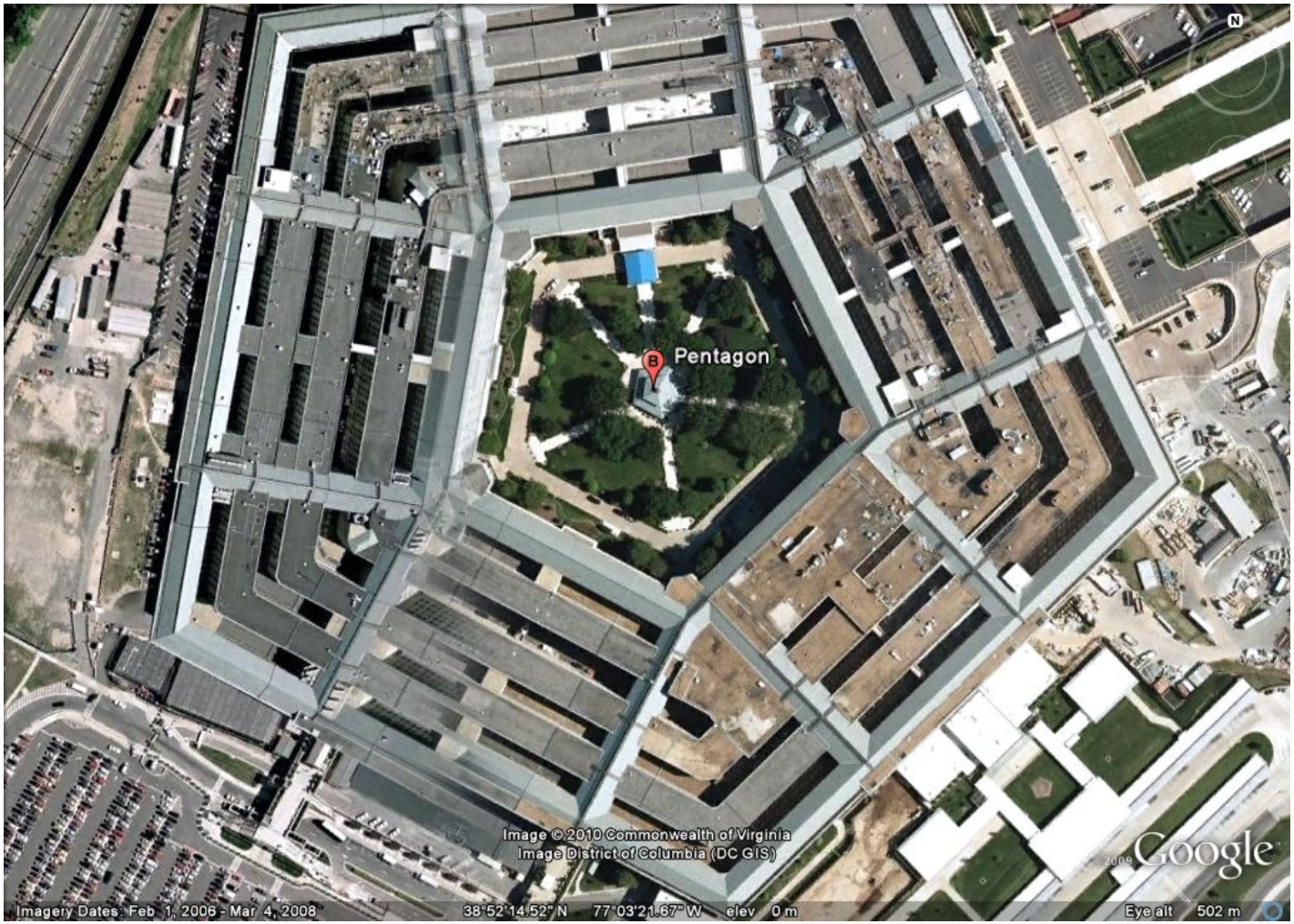
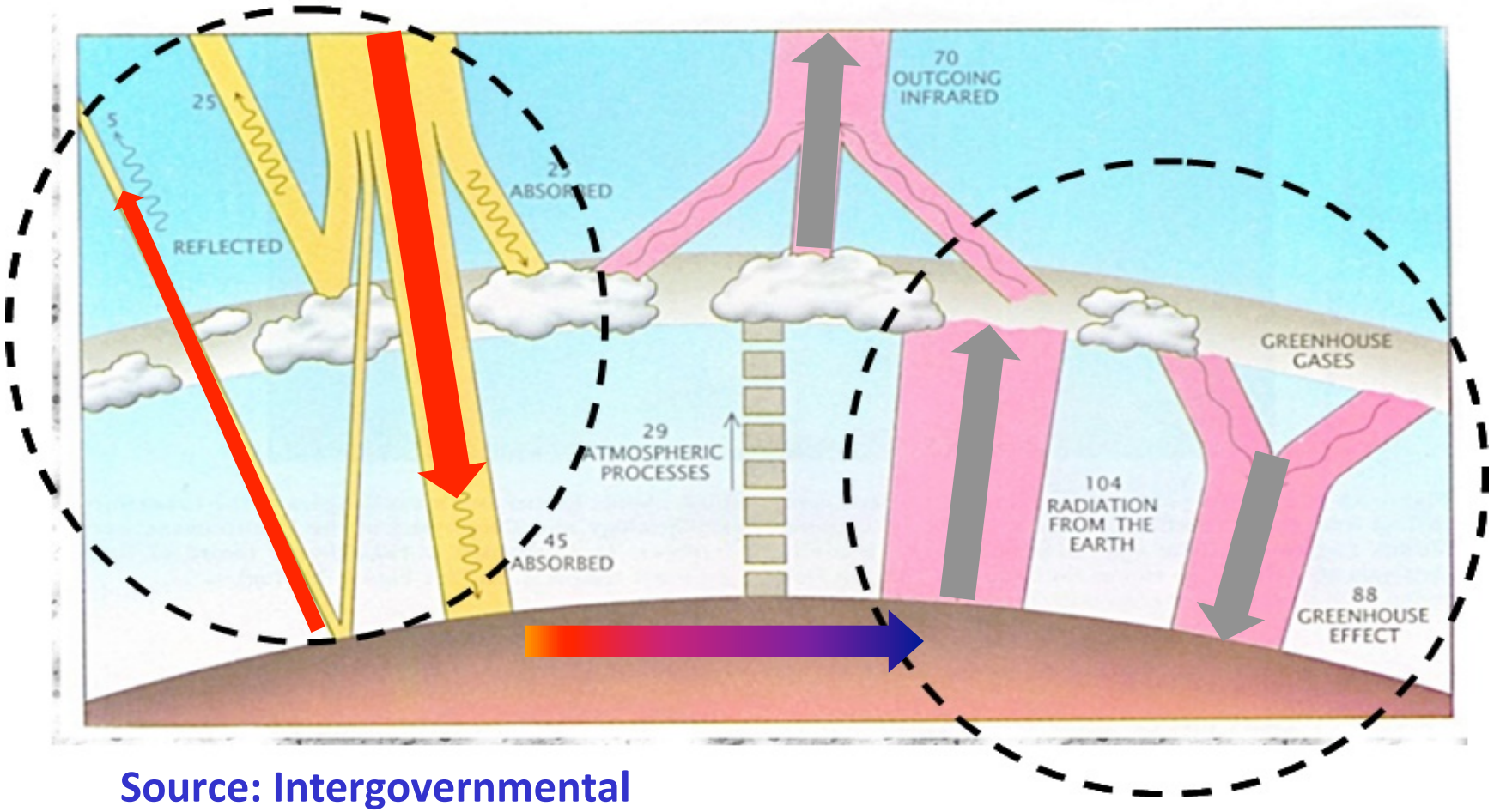
Pentagon


Pentagon
Image © 2010 Commonwealth of Virginia
Image District of Columbia (DC GIS)
Google
Imagery Dates: Feb 1, 2006 - Mar 4, 2008
38°52'14.52" N 77°03'21.67" W elev 0 m
Eye alt 502 m

Cooling our planet

Solar-reflective surfaces cool the globe via “negative radiative forcing”



Source: Intergovernmental Panel on Climate Change (IPCC)

35

GLOBAL COOLING: making 100 m^2 (1000 ft^2) of gray roofing white offsets the **emission** of 10 t of CO_2

36

How much CO_2 equivalent is offset if we whiten all eligible urban flat roofs world-wide? (i/ii)

- Answer: **24 Gigatonnes (Gt)**
  - 2/3 of a year's worldwide emission
  - Gigatonne = billion metric tons

- If implemented over 20 years (the life of a roof or a program) this is ≈ 1.2 Gt/year.

How much CO_2 equivalent is offset if we whiten all eligible urban flat roofs world-wide? (ii/ii)

- Offset is equivalent to **taking 300 million cars off the road for 20 years**.
  - There are about 600 million passenger cars world wide, and they each emit ≈ 4 t CO_2/ year.

In terms of avoided power plants

Full white roof potential avoids 500 medium-sized coal fired power plants or 1,000 medium-sized gas fired power plants

The whole global power system emits ~15 Gt(CO2 annually), equivalent to the output of 6000 typical midsized power plants (2/3 coal, 1/3 gas).

LAWRENCE BERKELEY NATIONAL LABORATORY PRESENTS:
SCIENCE AT THE THEATER

COOL CITIES, COOL PLANET

What to do now

Progress in energy efficiency standards

- In 2005, California's "Title 24" energy efficiency standards prescribed white surfaces for low-sloped roofs on commercial buildings. Several hot states are following.
- In 2008, California prescribed "cool colored" surfaces for steep residential roofs in its 5 hottest climate zones.
- **Other U.S. states & all countries with hot summers should follow.**

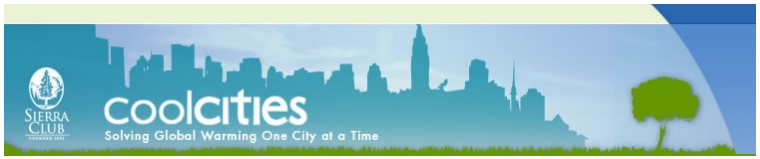
Recent cool roof progress (2005 – 2012)

- 2005
  - California Title 24 – “Flat roofs shall be white” (15 out of 16 climate zones). Walmart adopts white roofs for ALL stores.
  - EPA ENERGY STAR lists Cool Roof Materials
- 2010
  - June 1st, 2010 – Memo from U.S. Energy Secretary Steven Chu calls for all DOE Buildings to have white roofs, if cost-effective
  - June 16th, 2010 – Marine Corp follows suit, Pentagon following slowly
  - June 19th, 2010 – *RetroFIT Philly* announces winner of “coolest block” contest to white-coat black roofs of row houses.
- 2011
  - 100 Cool Cities launched – see www.WhiteRoofsAlliance.org
  - Spring 2011 – US will launch, at G20 Energy Ministers meeting, a voluntary Cool Roofs initiative and may even offer technical assistance to developing countries who join early.

To come 2013…

- Model codes will be modified to prescribe “flat roofs shall be white”
  - ASHRAE for commercial buildings
  - EECC for residential buildings
- But states and cities have to **adopt** model codes

Global Cool Cities Alliance could unite many initiatives and trade associations



American Council for an Energy-Efficient Economy

THE CLIMATE GROUP

Resources on the web

- **Art Rosenfeld's website**
  - ArtRosenfeld.org
- **Cool Colors Project**
  - CoolColors.LBL.gov
- **Heat Island Group**
  - HeatIsland.LBL.gov
- **Cool California**
  - CoolCalifornia.org
- **Global Cool Cities Alliance**
  - GlobalCoolCities.org
- **Cool Roof Rating Council**
  - CoolRoofs.org
- **EPA Heat Islands**
  - epa.gov/heatisland
- **Energy Star Cool Roofs**
  - EnergyStar.gov